General Anesthesia in Veterinary Practice

By Leon Zlotnick

(Continued from January)

Ether.—Ethyl ether has been more popular for general anesthesia in small animals than has chloroform, as the latter has been found rather dangerous in canine and feline work. Chloroform has a tendency to cause fatty degeneration of the liver in from 12 hours to 5 days following its use, and the resulting toxemia causes the death of the patient. Cats are very susceptible to this form of poisoning and dogs are much more susceptible to it than are the large animals.

On the other hand, the prolonged period of excitement resulting from the use of ether precludes its use in large animals. Ether may be successfully employed in foxes as reported by Wisnicky.[18]

In the following table a few comparative points of the two drugs are considered which are of interest to the practitioner.

Ether	Chloroform
1. Readily diffusible and volatile	1. Heavier vapor, less volatile
2. Irritating to respiratory mucosa	2. Slightly soothing to respiratory mucosa
3. Irritating to the kidneys	3. Non-irritating to kidneys
4. Reflexly stimulates the heart	4. Depresses the heart
5. Slower in action, long period of excitement	5. Quicker in action, short period of excitement
6. Less persistent in action	6. More persistent in action
7. Greater concentration required (about 70% drug)	7. Smaller ration of drug to air required
8. Inflammable	8. Non-inflammable
9. More expensive	9. Less expensive

From this table it may be seen that ether is to be avoided in cases of chronic bronchitis or renal disease. On the other hand, it would be the agent of choice in cardiac weakness for it increases the force of the pulse and raises blood pressure, whereas chloroform acts in the opposite manner. For this reason chloroform is safer in large animals where the cardiac impulse is more powerful than it is in small animals or humans. In humans it has been responsible for three times as many deaths as ether and the latter agent is preferred, other indications being equal.[10]

In administering ether to a dog or cat the principles are identical with those outlined for chloroform anesthesia in the horse or ox. The writer has seen ether used in small pigs and the induction of anesthesia in these animals was smooth and easy. In small animal work the use of ether is usually attended by a profuse salivation which sometimes becomes copious enough to fill the pharynx and occlude the larynx. The saliva also clogs up the cloth in the ether cone, retarding the evaporation of the ether. Anderson [2] recommends the subcutaneous injection of atropine sulfate twenty minutes before operating in doses of 1/100 to 1/50 gr. This leaves the mouth fairly dry during the administration of the other.

An ether cone is generally used with this form of anesthesia and the

elbow pattern is the more convenient, as it facilitates administration when the animal is recumbent. The period of induction should be made as short as possible as explained under chloroform anesthesia. Once the anesthetic stage is reached, cease further administration temporarily and then continue at intervals when necessary. Watch the mucous membranes carefully for cyanosis which indicates oncoming respiratory failure. If cyanosis is seen remove the ether at once. If respiration ceases, remove the ether, apply artificial respiration, admit plenty of fresh air and apply ammonia vapor cautiously.

Prevention of Complications in General Anesthesia

There are a few precautions which may prove of value to prevent complications. The use of atropine has already been mentioned. There is some dispute as to the advisability of fasting prior to anesthesia. Some writers (Milks) tell us to avoid a long period of fasting before chloroform to check the liability of fatty degeneration. On the other hand, others (Greig and Boddie) advise that the patient should be prepared by withholding bulky foods for about 36 hours previous to operation. This renders the animal liable to respiratory distress, and when the stomach is empty, anesthesia can be much more readily induced.

The use of preanesthetic medication or basal narcosis has found favor with many surgeons. There are good reasons for this. Firstly, a basal narcotic lessens the amount of anesthetic required and therefore the danger of anesthesia. Secondly, it shortens or even obliterates the period of excitement. Finally, in large animals it renders restraint easier and safer for both patient and operator. The two agents most commonly used for preanesthetic medication are morphine and chloral hydrate.

Morphine has a marked stimulating action on horses, cattle, sheep and swine. However, its action on dogs is one of cerebral depression. In cats its action is similar to the action in large animals. If given to a dog a few minutes before the beginning of general anesthesia the period of excitement will be greatly diminished and much less ether will be required. Atropine is often given in conjunction with morphine to inhibit salivation and vomiting. Morphine is especially useful in large dogs which would otherwise require a large amount of ether and a sustained effort on the part of the attendants to control their struggles. As a basal narcotic the dose of morphine sulfate subcutaneously is ¼ to ½ gr.

The administration of morphine sulfate intravenously has recently been introduced and the following advantages are claimed over the hypodermic route: The drug can be administered at the moment needed, full analgesic effects are immediately obtained, the dose can be regulated more accurately and there is less tendency to vomit.

Chloral hydrate is quite favorably regarded as a basal narcotic in large animals. For this purpose 1 or two ounces may be given either orally or intravenously. If given orally it should be given in 20% solution ½ hour before operating. If administered intravenously the 7% solution is used a few minutes before operating. While the local anesthetics do not come within the scope of this paper it may not be amiss to mention that chloral is often used in conjunction with a local, serving the same purpose that it does in general anesthesia. In this connection Guard [9] points out that chloral has of necessity become a very valuable substitute for general anesthesia in large animal practice. It is especially applicable under field conditions where the veterinarian operates without trained assistance.

Non-Volatile Anesthetics

The use of non-volatile anesthetics in general anesthesia has taken a tremendous upswing in the last decade with the introduction of the barbituric acid derivatives. The advantages of these agents over volatiles are:

1. The surgeon does not require a skilled anesthetist.
2. They can be used on animals suffering from respiratory infections without causing pulmonary irritation.
3. Once anesthesia sets in its maintenance requires no further attention.

In actual practice, however, it will be found that every so often a patient shows signs of collapse, just as he might under inhalation anesthesia, the difference being that it is impossible to withdraw the anesthetic—the surgeon has more or less committed himself to a certain dose. This factor has brought about the introduction of the analeptic drugs, which are the only resort in cases of overdosage with a non-volatile anesthetic.

Chloral Hydrate

For long and painful operations Fowler [5] recommends giving chloral hydrate via the stomach tube ½ hour before operating. The dose is computed at 4 drachms per 500 lb. body weight and is given in lukewarm water. If the intravenous route is chosen, the 7% solution is used and injected slowly. When the horse begins to weave from side to side he has had enough. Some surgeons prefer to restrain the horse and place him on the operating table before giving the intravenous injection, this requires more careful watching as anesthesia sets in.

Chloral hydrate although very useful in horses has resulted in a large percentage of fatalities when used for general anesthesia in cattle. Its action in this species is too irregular and it is more dependable as a basal narcotic. It is satisfactory in swine, the intraperitoneal route being the one of choice. For this purpose it may be used in a 7% solution the dose of which is 1½ cc per pound of body weight.

The signs of the various stages of anesthesia are about the same as in chloroform anesthesia but they are not as well marked. The excitant stage is almost imperceptible. Rolling of the eyeball is lessened or absent. The respirations are even; the jerky breathing seen in the induction of inhalation anesthesia is absent. The horse sinks into a deep sleep which deepens slightly after administration ceases and then remains constant for about ½ hour. If the operation is prolonged beyond this time, more chloral can be given intravenously, but if the initial dose was large it is safer to finish with a local anesthetic wherever possible. Recovery will be found to be slower than with chloroform anesthesia. The heat regulating center is seriously depressed—blanket the horse for several hours after in cold weather and watch out for heat stroke in hot weather. The pharyngeal reflex is depressed for some time. Withhold feed and water for 5 hours to avoid mechanical pneumonia.

There is no physiological antidote for chloral hydrate but caffeine may be employed intravenously in case of cardiac or respiratory failure. Greig and Boddie state that strychnine is the antidote to chloral poisoning but this statement should be taken with reserve. Competent observers with extensive experience show very little enthusiasm for any antidote so far introduced. Only one point of practical importance has so far emerged: animals kept warm artificially are able to withstand larger doses than those normally used without toxic symptoms setting in. However, no one has recom-

mended blanketing once the symptoms appear so that even this procedure is of limited value.

The use of chloral hydrate for general anesthesia is very popular in continental Europe and increasing steadily in America. It is not popular in Britain except as a hypnotic, Greig and Boddie[8] pointing out that it is rarely used in that country. O'Connor[13] objects to its use on the ground that it frequently sets up a severe phlebitis; however, Savage pointed out as long ago as 1919 that if suitably diluted and injected slowly so as to be well diluted in the blood stream before contacting the blood vessels, no phlebitis would occur. Apart from this all that is required is care in preventing subcutaneous escape of the solution when injecting.

To obtain uniformity of action chloral hydrate crystals should be stored in a dark, well-stoppered bottle. The solution should not be stored but always made up fresh for use as recommended by McIntosh, Fowler, Goffinet[7] and many others. This obviates possible loss of potency through evaporation or precipitation.

The Barbituric Acid Derivatives

The barbiturates are a group of drugs derived from barbituric acid, a few of them being sodium salts of that acid. They have come into prominence as hypnotics and anesthetics during the last ten years, being used extensively in human and in small animal work. Barbital was introduced as early as 1903 under the name "veronal", so that the introduction of this group of drugs is not as recent as is often supposed. This widespread adoption however, did not occur until 30 years later. Only those commonly used for general anesthesia will be considered here.

Classification.—The barbiturates may be classified as long and short acting and the two groups should not be used interchangeably. Barbital and phenobarbital are long acting, nembutal is short acting and pentothal sodium is very short acting.

The effects of the long acting barbiturates persist for periods varying from 18 to 36 hours. They are eliminated through the kidneys, hence diuretics are indicated if the effects persist an unduly long time. This group is contra-indicated in renal disease as they are then too slowly excreted.

The effects of the short acting barbiturates such as nembutal persist about 3 to 6 hours. Nembutal is destroyed mostly in the liver, hence its use would be contraindicated where hepatic disease is known to exist. Apart from these specific contraindications, barbiturates are generally contraindicated in circulatory disturbances, acidosis and anemia.

The effects of the very short-acting group are rather dramatic when witnessed for the first time. Anesthesia from pentothal sodium sets in instantaneously once administration is complete. The effects last about 8 to 10 minutes and in 30 minutes the drug has been completely destroyed by the liver and the animal quickly becomes normal.

Methods of Administration.—Barbiturates in capsules may be administered orally. This is a common method of administration in the cat. Anesthesia will set in about ½ hour provided the stomach has previously been emptied by fasting.

Intraperitoneal injections are useful in very small animals such as mink, kittens and pups. However, there seems to be some difficulty in standardizing the dosage for this route of administration.

Intravenous injections should be made slowly allowing 3 to 5 minutes

to elapse while administering the full dose. Many of the hazards that some surgeons complain about arises from too rapid intravenous injection. The standard dose should be drawn into the syringe but in administration the anesthetist should be guided by the pupillary reflex. Dilatation of the pupil occurs first, followed by contraction. When the pupil reaches 1/4 the size of the normal pupil a sufficient dose has been given.

In order to avoid the possibility of shock from too rapid parenteral injection nembutal can also be injected rectally. Elder [4] mentions this method of administration in a zoo in chimpanzees which would not take capsules disguised in the food. Rectal injection produced complete anesthesia in a few minutes. Generally speaking, however, this method is not recommended as it has little to offer in the way of controlling the anesthesia, its only advantage being the somewhat slower absorption than from parenteral injection.

Nembutal.—Nembutal is frequently used in small animal practice either as a powder in prepared capsules or as a sterile solution, 1 cc of solution containing 1 gr. of powder. The dose recommended is 1 cc for every 5 lb. of the body weight until 10 cc have been given after which the dosage should be drastically reduced. It is essential when using this drug that the body weight should be accurately determined by weighing the animal instead of by estimation. In March 1942 at the O.V.C. Clinic 19 cc of nembutal was given to a dog weighing 160 lb; however, this is an exceptionally large dose and measures of safety would suggest finishing the anesthesia with ether rather than increasing the dose of nembutal to the limit.

Apart from small animal practice nembutal is recommended for anesthetizing swine. Although its use in this species is not extensive it may be successfully employed on the same dose scale recommended for small animals. Some authorities recomend the use of nembutal in foals and calves, but on account of the large doses required the writer does not believe its use is economically feasible in these animals hence it will not be discussed in this paper.

Wisnick [18] reports the successful use of nembutal in foxes and mink. The average dose for a fox is 1.7 cc intravenously. The average dose for a mink is 1/5 cc intraperitoneally.

Other than depression of the respiration, nembutal is singularly free from harmful actions. Circulatory depression rarely occurs except with doses beyond the range of ordinary clinical error. However, one is prone to become careless in the calculation of dosage and in administration especially if the anesthetic has been employed in numerous subjects without accident. It should be remembered that large individuals require less and small ones more than the standard dose. Finally, patients showing undernourishment, toxemia or shock should be especially closely watched with regard to respiration while under nembutal.

Pentothal Sodium.—Pentothal sodium is a very useful drug for anesthesia of short duration. One of the great disadvantages of nembutal is the narrow safety margin between anesthesia and respiratory failure. Pentothal sodium offers a safety margin which is wider than that of any of the barbiturates. Sweeb [16] gives the dose as 1 grain per 10 lb. body weight in dogs. As in all barbiturates, the animal must be accurately weighed. Pentothal sodium is indicated in minor operations and the initial dose can be repeated if it becomes necessary to prolong the anesthesia. The necessity for slow injection cannot be over-emphasized.

Mostyn[12] quoting Blackberg and Hrubetz reports that fasting for 24 hours materially increases the duration of barbiturate anesthesia and the susceptibility of dogs to barbiturate action. Hence dogs should not be starved before administering a barbiturate unless it is to be given orally and then only long enough to empty the stomach.

Analeptics

Analeptics are agents which are physiological antagonists of cerebral depressants. The ones in common use are picrotoxin, metrazol, caffeine, and strychnine and of these the first two are used in barbiturate poisoning. The action of metrazol is characterized by its early effect while the maximum action of picrotoxin may be delayed as much as 15 or 20 minutes. Picrotoxin appears to be the safest of the analeptics and metrazol the most effective.

When rapid, complete arousal from barbiturate depression is produced by metrazol or picrotoxin it may be accompanied by dangerous convulsion; therefore immediate, complete reversal of the depression should not be attempted. Rather one should be satisfied with steady improvement of a lesser degree.

Alfredson[1] gives the dose of metrazol as 1 cc of the 10% solution for dogs under 20 lb. and 2 cc for dogs over this weight. Administration may be intravenous, intraperitoneal or subcutaneous. The dose should be repeated at 2 or 3-minute intervals if necessary. This treatment is usually successful in reinstating respiration.

Among the common stimulants found ineffective in barbiturate poisoning strychnine seems worthy of mention since it is recommended for collapse under chloroform anesthesia. Although nembutal is commonly used in strychnine poisoning the reverse action does not occur.

In cats there is often unpredictable deviation in tolerance to the normal dose of barbiturate anesthetics. This is manifested by sudden death from respiratory failure or else unduly delayed recovery from the anesthesia. In these animals, Pleuger[15] reports that he routinely gives postoperative doses of .5 cc of metrazol followed by another .5 cc ½ hour after the operation. He claims that he has thereby eliminated most of the complicating factors peculiar to the non-volatile anesthetics, especially in the anesthesia of old, emaciated and toxic animals.

Conclusion

While this paper discusses all of the anesthetics which are in common use in veterinary surgery it should not be supposed that others are not used. Cyclopropane, A.C.E., nitrous oxide, chloralose and luminal are worthy of mention. These and many other agents are anesthetics which for one reason or another do not find a sufficiently widespread use in clinical work to warrant description. The anesthetic drugs commonly used are not perfect, they differ from the less common ones merely in possessing fewer disadvantages. In the words of the late Sir Frederick Hobday, "The ideal anesthetic which will combine definite efficiency with fool-proof safety from toxicity is yet to be found".

Acknowledgement

The writer wishes to acknowledge the kindness of Dr. E. N. Anderson, of Winnipeg for many helpful suggestions; and also to thank Drs. R. A.

McIntosh and W. J. R. Fowler of Guelph, whose lecture notes were freely consulted. Quotation has been made freely from the sources listed and the author is indebted to the authors mentioned.

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Dr. E. A. Watson Resigns

DR. E. A. WATSON, Chief of the Division of Animal Pathology, Science Service, Department of Agriculture, has resigned on account of ill-health. An account of his career and services will be given in a future number of the Journal.

Edison Bidwell Ungar

EDISON BIDWELL UNGAR, District Veterinary Inspector of the Health of Animals Division, Department of Agriculture, died suddenly at Moncton, New Brunswick, February 2nd, 1943, in his sixty-third year.

Dr. Ungar was born at Napanee, Ontario, and graduated from the Ontario Veterinary College in 1919. He served overseas in the Great War for over three years.

Dr. Ungar was in charge of the work of the Health of Animals Division in the Maritime Provinces. He was a hard-working conscientious officer. He is survived by his widow.